IN THE SPECIFICATION

In the paragraph that begins on page 1, line 18, please make the following amendments:

Cherrypickers are currently in use in digital broadband cable TV data delivery systems. An example of this type cherrypicker are the headend multiplexers sold commercially by Terayon Communications Systems, Inc. of Santa Clara, California. In the broadcast digital cable configuration, a plurality of headend cherrypicker multiplexers receive a plurality of digital MPEG compressed video data transport streams through a plurality of splitters. The inputs of the splitters are MPEG transport data streams from satellite downlinks or video servers. The outputs of the splitters have to be hardwired to the inputs of a plurality of cherrypicker switches that do the job of culling out the desired MPEG packets. This creates a rat's nest of point-to-point connections which have to be manually wired and, when a change occurs, have to be manually re-wired.

In the paragraph that begins on page 3, line 10, please make the following amendments:

Figure 1 is a block diagram of an improved cherrypicker according to the genus of the invention which uses a network switch and IP wrapper technology on the front end to replace the handwired splitter network.

In the paragraph that begins on page 13, line 1, please make the following amendments:

Next, step 117 encapsulates the IP packet in an ~~and~~ Ethernet (or other LAN) packet and generates an Ethernet station address from the IP packet destination address in the same way as previously described for step 45 of Figure 3. Finally, step 119 outputs the Ethernet packet to the packet switch 10 and starts over for new incoming MPEG packets. Step 119 also, optionally, resets the PID buffer counter and clears the PID/multiplex pair list. The reason this is preferred is that the number

of PIDs in use at any particular time varies up and down so if the PID buffer counter is never reset from some peak value of PID buffers when far fewer PIDs are currently in use, time will be wasted by the computer in checking buffers for PIDs that are no longer in use.

In the paragraph that begins on page xx, line xx, please make the following amendments:

In still other "load balanced" embodiments, there will be a management and control process in computer 44 that knows how many tuners each users has and keeps track of the number of requests each user has currently being serviced and will transmit load balancing data to each cherrypicker switch via Ethernet packets telling each cherrypicker switch which PIDs or Ethernet station addresses to request from switch 10 and which logical channels and subchannels to put them on as MPEG transport streams. The computer 44 will take into account how many tuners each user has and attempt to honor all requests from that user ~~users~~ on open subchannels of a number of logical channels that does not exceed the capacity of that user's gateway to simultaneously tune or otherwise receive. Any algorithm to do a load balancing function and accommodation to the number of tuners each user has is within the scope of the invention.

In the paragraph that begins on page 20, line 26, please make the following amendments:

The cherrypicker switches construct their transport streams from the data sent by the packet switch 10. In this process, they do any necessary bandwidth adjustments to conform the streams consumed bandwidth to the available bandwidth of the downstream medium. Available bandwidth information and the PIDs of any programs to be "pushed", that are ~~is~~ transmitted even though there have been no specific requests are sent to the cherrypicker switches by a management and control process. This process can run on computer 44 and send information to the

cherrypicker switches by Ethernet packets routed via data path 52, switch 10 and LAN segments 70 and 72 or by dedicated data path 54 in some embodiments. In other embodiments, a separate management and control process running on another computer (not shown) can perform this function and send the necessary data to the ~~the~~ cherrypicker switches 30 and 32 by any suitable data path.

In the paragraph that begins on page 21, line 27, please make the following amendments:

Other Ethernet packets that encapsulate IP packets with TCP and IP headers from the internet that the customer requested and which have been routed through the packet switch 10 to a cherrypicker switch are passed to a TCP/IP protocol stack. This protocol stack is resident in a computer in the cherrypicker switch. The TCP protocol uses the port address in the TCP header to establish a logical connection to the particular process running in a computer at the customer site that has that particular port address and cooperates with its peer process at the customer site computer to keep track of the blocks of data to insure that all are delivered reliably. This logical connection is established over a logical channel on whatever downstream medium is being used for the downstream and upstream connections. The IP protocol in the cherrypicker switch using the IP destination address in the IP header to route the IP packet data to the proper IP packet stream that will be transmitted over the logical channel to the host at the customer site that has been assigned to that IP address. When each process at the customer site that desires broadband internet access boots up, it establishes an upstream connection to an address resolution protocol process running on computer 44 or some other computer at the headend (or central office, i.e., "CO", where the cherrypicker switches are). This connection is established over whatever upstream data path connects the customer site to the headend or CO. The address resolution protocol establishes a TCP port address for the process and an IP address for the host on which the

process is running. ~~That~~ The process that received the port address and the host IP address then uses that TCP port address and host IP address as source addresses in subsequent requests for IP data from the internet or other sources. Whatever computer that assigns the TCP port address and IP address for a process at a customer site transmits the address information along with a customer ID to the specific cherrypicker switch(es) that will be generating the IP packet stream(s) that goes to that customer site. The cherrypicker switches can then use the destination port address in the TCP header and the IP destination address in the IP header of incoming TCP/IP packets to route the data to the proper packet stream. That packet stream will be transmitted on a particular downstream logical channel and subchannel to the customer and a downstream message will be sent to the customer telling her tuner(s) where to tune to receive this IP data. The processes of using TCP/IP protocol stacks to transmit data over different kinds of networks from one host to another are described in Stallings, *High Speed Netowrks, TCP/IP and ATM Design Principles* (Prentice Hall 1998) ISBN 0-13-525965-7 which is hereby incorporated by reference.

In the paragraph that begins on page 22, line 27, please make the following amendments:

Step 127 represents the process of re-inserting new MPEG timestamps into each MPEG transport stream and re-compressing the data down to the available bandwidth for digital data delivery to this customer site. The decompression and recompression are done by recoder integrated circuits which are publicly known and which are commercially available from Terayon Communication Systems, Inc. of Santa Clara, California. These recoder chips have been patented by Imedia as U.S. patent 5,956,088, which is hereby incorporated by reference. In simple embodiments where every user has a fixed assigned bandwidth that does not vary, this simply involves looking up the available bandwidth for this user and recoding down to that bandwidth. In more complex embodiments where a

management and control process is monitoring available bandwidth, ~~there~~ step 127 still involves a table lookup, but there is an auxiliary process which receives updates on available bandwidth for each user from the management and control process and updates the entries in the table for each user.

In the paragraph that begins on page 23, line 14, please make the following amendments:

The UDP/IP or TCP/IP protocol stacks add TCP or UDP header information that addresses the data to the particular port for the process that requested it, and the IP stack adds header address information addressing it to a particular host at the customer site. The term "host" is intended to mean any computer, settop decoder box, digital VCR, videophone, intelligent remote with video preview capability or any other circuit running one or more processes which consume video or other data. The resulting packet is sent to the network MAC layer which encapsulates ~~encapsulated~~ it into an Ethernet packet addressed to the IP dewrapper circuit 76 in Figure 1 and transmits it over LAN link 70 or 72 to the packet switch, as symbolized by step 131. The packet switch then routes the packet to the IP dewrapper circuit via LAN segment 74. The preferred medium type and protocol for LAN segment 74 is 100BaseT Ethernet.

In the paragraph that begins on page 23, line 25, please make the following amendments:

The IP dewrapper circuit 76 functions to strip off the Ethernet and IP packet header information and sort out the different MPEG transport streams and route them to the appropriate DSL modem or put them into the appropriate logical channel and subchannel on the downstream HFC or other medium. In environments where all the customers have settop decoders that can receive Ethernet packets containing IP packets containing MPEG packets and strip off the Ethernet and IP packet headers and decompress the MPEG packets to generate video and/or audio signals and IP data, and the downstream media is capable of transmitting Ethernet packets, the IP dewrapper circuit 76 is not necessary. Such

embodiments are especially useful in Fiber To The Curb environments which will become more prevalent in the future. In the preferred embodiment, the IP dewrapper circuit is implemented by a field programmable gate array.

In the paragraph that begins on page 24, line 4, please make the following amendments:

It will be understood by <u>those</u> ~~thos~~ skilled in the art that there is an important class of alternative embodiments where no IP dewrapper circuit at all is used. This class of embodiments functions in environments where the downstream channel can carry TCP/IP packets and each customer has a distribution network to one or more host computers running one or more MPEG and IP data consuming processes each of which has its own TCP port address. In other words, this class of embodiments with no IP dewrapper are used in environments where every customer has TCP/IP connectivity capability to every process in the customer's distribution network. Such environments include home gateways which distribute incoming data from satellite, HFC, DSL and other sources to different host computers and set top decoder processes via one or more local area networks. In such embodiments, the TCP/IP (or UDP/IP) header information added to the TCP/IP (or UDP/IP) packets that transport the MPEG transport stream data is important in making sure that each MPEG transport stream reaches the correct process at the customer site.

In the paragraph that begins on page 25, line 15, please make the following amendments:

The UDP or TCP header 150 is optional in embodiments to be used where there is no TCP/IP connectivity to the requesting process. In these embodiments, the customer usually only has one or two tuners and no gateway with the tuners connected to a display device like a TV. In this environment, there is no need for a port address in the UDP header, and the requested or pushed video and audio data is transmitted to <u>the customer</u> ~~him~~ on a logical channel and subchannel which is identified in a downstream message. The tuner then tunes to that channel and recovers the MPEG transport stream and filters out the

packets with the PIDs of the desired programs and converts that data to a video and audio signal to feed to the display device. There is no ~~not~~ packet routing needed at the customer location in this simpler embodiment, so the UDP header is optional. **In the paragraph that begins on page 27, line 1, please make the following amendments:**

Step 143 is performed if the downstream medium is HFC. In step 143, the IP packet header information is stripped off the IP packets bearing the MPEG data of each MPEG transport stream and the MPEG transport stream is reassembled and sent to the correct cable modem modulator for the 6 MHz bandwidth logical channel on which it is to be sent. There may be a single cable modem for each downstream carrier/logical channel to carry one transport stream. In such a case, the transport stream is sent to the proper modem MPEG data input. If one cable modem with multiple downstream ~~downstram~~ modulators is used, the data from each transport stream is sent to the correct modulator input.

In the paragraph that begins on page 27, line 9, please make the following amendments:

MPEG transport streams use fixed length, relatively short data structures that can be well processed in a networked environment. They are defined in Orzessek and Sommer, *ATM & MPEG-2, Integrating Digital Video into Broadband Networks,* (Prentice Hall 1998), ISBN0-13-2453700-7, the entirety of which is hereby incorporated by reference. The relationship between access units of elementary streams and the Packetized Elementary Stream (PES) packets that are generated from the elementary streams and the Transport Stream packets (referred to herein as MPEG packets) generated at fixed lengths from the variable length PES packets is shown in Figure 3.22 at page 105 of the Orzessek treatise. The PES packet headers include data about the type of elementary stream (video or audio) data which is in the payload, while the MPEG packet header includes ~~inclddues~~ information needed to transport and deliver the stream. There are Single Program Transport Streams (SPTS) which carry different PES streams which all share a common time base and Multi Program Transport Streams which are a multiplex of a number of SPTS each of which has a

different timebase.

In the paragraph that begins on page 29, line 4, please make the following amendments:

The recoder farm 156 is comprised of one or more recoder integrated circuits which function to receive MPEG data ~~in~~ having a certain bandwidth and alter the bandwidth in accordance with bandwidth control commands received at a port 164. These recoder chips can be structured in accordance with the teachings of U.S. patent 5,956,088 which is hereby incorporated by reference and are commercially available from Terayon Communications Systems, Inc. of Santa Clara, California. Figure 9 gives more details of the circuitry of the recoder farm 156.

In the paragraph that begins on page 29, line 11, please make the following amendments:

Typically the bandwidth control commands are sent from the motherboard computer in accordance with the downstream data paths being used and the particular customer to which the data is being sent and the particular process at the customer premises to which the data is being sent. In some embodiments, all customers ~~customer~~ have simple installations which have one or more tuners which can recover digital data transmitted at a fixed bandwidth. In these embodiments, the bandwidth control commands simply specify each MPEG transport stream going to such a customer be re-compressed down to the bandwidth available on the downstream link to that customer. In other embodiments each customer may have a different available downstream bandwidth based upon the amount the customer paid for a subscription. In these embodiments, the available bandwidth for each MPEG transport stream directed to each customer is looked up in a look-up table and an appropriate bandwidth control command is sent. In other embodiments, especially those with UDP/IP connectivity all the way to all customer processes, each customer will have a different available bandwidth on their LAN which is reported upstream to computer 44 in an upstream management and control message from time to time and recorded in a look-up table entry for

that customer. In addition, certain processes at that customer's premises may have different bandwidth capabilities which are specified with each upstream VOD request from that process. For example, an HDTV's settop decoder may have a large available bandwidth which is supported both by that customer's gateway and LAN and which is reported with VOD requests from that settop decoder. That customer may also have an intelligent remote with its own low resolution liquid crystal display which is used to preview channels before actually making a VOD request for the program. The process that drives that display will have a much lower maximum bandwidth capability, and that bandwidth capability will be reported with upstream VOD requests from that remote control. Thus, the lookup table for that customer will have one entry for the HDTV that reports a large maximum bandwidth capability for packets directed to the port owned by the settop decoder for the HDTV, and another entry for the remote reporting a much lower maximum bandwidth. Computer 44 will look up the maximum bandwidth available for transport streams directed to these two different UDP port addresses and generate appropriate bandwidth control messages on line 164 for the recoder chips that are processing those transport streams.

In the paragraph that begins on page 32, line 8, please make the following amendments:

The router 182 also functions to receive MPEG transport streams assembled by the motherboard 188 and transmitted to it over the PCI bus 194 and packetizes ~~packetize~~ them into IP packets. In embodiments where there is TCP/IP or UDP/IP connectivity all the way to the consuming process, the motherboard may send messages to the router instructing it as to what UDP port address and IP host address to use for each transport stream. The router then packetizes these IP packets in Ethernet packets addressed to the IP dewrapper 76 in Figure 1 in embodiments where there is no UDP/IP connectivity to the consuming process. In embodiments where there is UDP/IP connectivity to the consuming process, the router addresses the Ethernet packets to the appropriate DSL modem or cable modem that will transmit the MPEG transport stream.

In the paragraph that begins on page 35, line 4, please make the following amendments:

The "from" circuit 212 also does a PID picking function, but it picks off PIDs for audio, auxiliary data and IP packet data from the internet that are in residue MPEG packets entering on bus 208. By the time the MPEG packet data on bus 206 has passed through the last "to" circuit in the chain, all the video PIDs have been picked off, and the data is turned around and coupled onto bus 208. At this point, the only MPEG packets ~~packet~~ left are audio, auxiliary data and IP packet data from the internet or voice or IP packets. Although we stated earlier that the router 182 in Figure 9 sends all these packets to the motherboard 188, that only represents one embodiment. The preferred embodiment is to do this routing in a distributed fashion and use the "from" circuits to do part of the work for the router to keep from overwhelming it. The particular audio, data or IP packet PIDs that get picked off by each "from" circuit are specifed to each "from" circuit by a control message from the motherboard. The "from" circuit also sets a "magic" bit (referred to in the claims as a marker bit) in the header of each MPEG packet containing audio, auxiliary data or IP internet data it picks off bus 208 and transmits the packet back toward router 182 on bus 208.

In the paragraph that begins on page 38, line 6, please make the following amendments:

The modem 46 strips off the LAN packet headers and sends the encapsulated TCP/IP or UDP/IP iData packets downstream via downstream physical data path 29. If modem 46 is a cable modem, it can be any type of cable modem, but is preferably DOCSIS compliant. If cable modem 46 is DOCSIS compliant, the incoming iData packets are encapsulated in MPEG packets and transmitted over the HFC 29. Other types of downstream circuitry for modem 46 may also be used to, for example, encapsulate the iData packets into ATM cells or transmit the iData packets directly by interleaving the data of the iData packets, and modulating it onto a downstream carrier and using any form of multiplexing to keep it separate from other data addressed to different users and command

and control messages. Downstream command and control messages are also sent via modem 46 to tell customers the logical channels and PIDs on which broadcast and requested video programs are being transmitted. Suitable cable modems to do this are commercially available from several sources. Upstream requests for VOD selections and upstream iData are sent to modem 46 over upstream data path 50 and are output as ~~at~~ LAN packets encapsulating TCP/IP or UDP/IP packets addressed to the appropriate host and process. For example, upstream VOD requests are encapsulated in LAN packets encapsulating TCP/IP or UDP/IP packets addressed to computer 44. On the other hand, upstream iData commands, menu selections and other data are encapsulated in LAN packets encapsulating TCP/IP or UDP/IP packets addressed to the appropriate web server 22 or application server 25. Both sets of LAN packets are transmitted to packet switch 10 over LAN link 31 and are routed to the appropriate host in the headend equipment, as described above.

In the paragraph that begins on page 39, line 16, please make the following amendments:

The third embodiment represented by Figure 1 uses modem 56 for upstream video-on-demand requests and upstream iData requests and commands only. The upstream iData and VOD requests and commands are packetized and sent to computer 44 which processes them as above described for the first embodiment. Downstream messages however are sent to the appropriate cherrypicker multiplexers for transmission in the MPEG transport streams to the appropriate customers. The computer 44 sends messages to the web servers and application servers telling them what PIDs to assign to the iData when it is encapsulated into MPEG packets which are encapsulated into TCP/IP or UDP/IP packets and LAN packets and given multicast addresses. In this embodiment, the multicast addresses are generated as is the case for video program data. Further, computer 44 instructs packet switch router 44 to route iData and video program data according to their PIDs to the appropriate cherrypicker multiplexers which are generating the MPEG transport stream for the customer to which the

iData and video data is bound. The computer also sends messages to the cherrypicker multiplexers ~~multiplexer~~ telling them which PIDs various iData and video program data will have and which customers requested the iData and video program data. The cherrypicker multiplexers ~~multiplexer~~ then use the assigned PIDs in the incoming LAN packets to put the iData and video program data into the correct MPEG transport stream for transmission to the customer which requested it. In some embodiments there will be TCP/IP or UDP/IP connectivity all the way to the host and process at the customer which requested iData or video data. In such embodiments, the messages from the computer 44 to the VOD servers or their IP wrapper circuits, web servers and application servers instruct them to packetize the requested data into TCP/IP or UDP/IP packets addressed to the host and process at the customer location and encapsulate these packets in LAN packets addressed to the particular cherrypicker multiplexer which will transmit the data to the customer which requested it. The packet switch then routes these LAN packets to the appropriate cherrypicker multiplexer, or multicasts the LAN packets to all of them if the LAN packets have a multicast address. The cherrypicker multiplexer then strips off the LAN packet headers and examines the TCP/IP or UDP/IP destination address to determine whether the packet is addressed to a customer that cherrypicker multiplexer serves. Then, in some embodiments, the cherrypicker switch adjusts the bandwidth of the video data to the available downstream bandwidth or the bandwidth of the receiving process. The cherrypicker switch may also then adjust the bandwidth of the iData, if necessary per the type of data being transmitted or the bandwidth of the destination process or the bandwidth of the downstream channel. The altered bandwidth video data and iData is then repacketized in TCP/IP or UDP/IP packets addressed to the host and process at the customer location that requested it. The TCP/IP or UDP/IP packets are then simply sent from the cherrypicker multiplexer to the downstream transmitter for transmission on the appropriate logical channel. At the transmitter, the packet data is interleaved and different packets destined for different customers are multiplexed if necessary to keep them separate from each other. Downstream command and control messages are sent by

computer 44 to the customers as TCP/IP or UDP/IP packets telling them which logical channels to tune to receive the requested data.

In the paragraph that begins on page 42, line 12, please make the following amendments:

A conventional packet switch router routes LAN packets on LAN links to the cable modem 46 and all the cherrypickers as previously described in the discussion of Figure 1. The packet switch router is coupled by LAN links to multiple sources of packets. MPEG video data encapsulated in UDP/IP packets encapsulated in LAN packets addressed as previously described are supplied from IP wrapper circuits 277 ~~276~~ and 278. IP wrapper 277 ~~276~~ encapsulates MPEG packets from MPEG transport streams supplied from broadcast sources such as satellites and other cable system headends, as represented by cloud 280. IP wrapper circuit 278 supplies LAN packets encapsulating MPEG video packets and other TCP/IP packets supplied from VOD, near VOD and personal video recording servers and other types of servers in server farm 282. Near video on demand servers are servers that broadcast pay-per-view video programs on a frequent basis, usually the same movie over and over, and personal video recording servers are TIVO servers at the head end that record video programs requested by users in upstream requests and perform the other TIVO functions such that each customer can have a personal TIVO space at the head end with the TIVO functionality implemented by shared harware and software. The other types of servers in the server farm can include: EMM servers that supply auxiliary data for video programs, weather, new, stock reports, traffic information and other useful data; EPG servers that serve up electronic program guide data; web servers that convert HTML packets from the web servers in internet cloud 284 or from web servers in the server farm 282 to MPEG or other data formats so that users without computers can surf the web using their TVs and wireless keyboards or wireless remotes or other devices; Tmail servers that convert e-mail messages to MPEG or other video data that can be converted to a video signal that can be displayed on a user's TV to allow the user to send and receive e-mail using their TVs and

using wireless keyboards or wireless remotes; data carousel servers that serve up data similar to teletext messages; and transcoder servers that transform streaming video and streaming audio TCP/IP packet streams into MPEG 2 transport streams and convert MPEG 1 transport streams to MPEG 2 transport streams, and convert quicktime and real player formatted data in TCP/IP packets to MPEG 2 transport streams.